PATENT SPECIFICATION

806,406

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COMPLETE SPECIFICATION

Cutting Inserts for Rock Drill Bits

We, SANDVIKENS JERNVERKS AKTIEBOLAG, of Sandviken, Sweden, a Swedish joint stock company duly organized under the laws of Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to rock drill bits, and more particulary to cutting inserts of hard metal for rock drill bits.

In order to obtain good performance from a rock drill bit cutting insert it is important for it to have a high strength (in order to achieve the maximum distance drilled in relation to hard metal consumed), and to have sufficient toughness to avoid breakage and crumbling to pieces due to the great mechanical stresses set up during boring with modern percussion drilling machines. A cutting insert must therefore combine highest possible strength with highest possible toughness.

In conventional homogeneous, hard metal cutting inserts, e.g. cutting inserts with a uniform grain size and composition, it has been necessary to compromise between resistance to wear and toughness. The fact is that if the hardness and consequently the resistance to wear is increased, by changing the composition and/or grain size, the cutting insert becomes more brittle, and conversely if the toughness and the mechanical strength is increased the cutting insert has a lower resistance to wear. Hard metal cutting inserts have therefore been produced with separate zones which have different resistance to wear and tenacity properties. It is known that, other factors remaining constant, the wear resistance of hard metals may be increased by lowering the bonding metal content and it is also known to position zones of more wear resistant hard metal at the ends of the cutting insert, on the periphery of the bit and/or along the edge of the cutting insert. These inserts, however, are difficult to produce and are subject to certain technical drawbacks.

A cutting insert of hard metal, according to the invention, comprises a zone consisting of discrete granules of relatively hard fine-grained hard metal embedded at random in a matrix of relatively tough coarse-grained hard metal. The said zone may, in fact, comprise the whole of the cutting insert or, as will hereinafter appear, the zone may form a part or parts of the insert. The fine-grained and the more coarse-grained hard metal preferably have the same chemical composition by analysis or are such that the fine-grained granules have a higher content of bonding metal than the coarse grained hard metal.

By " hard metal " is meant a sintered alloy, consisting of one or more carbides, for instance tungsten carbide, and/or other hard materials (such as suitable borides and silicides), combined with one or more bonding metals such as cobalt, and/or other metals in the iron-group of the periodic system. Variations in resistance to wear and toughness of hard metal may, as is known, be obtained by increasing or decreasing the grain size, i.e. the mean grain size of the hard material particles, and/or by variation in the composition by analysis, for example by variation in the percentage content of the bonding metal.

Throughout this specification reference is made to (1) the grain size in the hard metal, i.e. the particle size of the hard material particles such as WC used in making the hard metal which is formed by bonding hard material particles together by means of a metal such as Co and (2) to the size of the granules of fine-grained hard metal used in forming the inserts. The grain size in the hard metal is measured in microns while the size of the fine-grained hard metal granules is measured in millimeters.

In using the expression " relatively hard fine-grained " in relation to the granules we are referring to the hardness of the grain size in the hard metal granules relative to the hardness of and the grain size in the matrix, and, similarly, in referring to the matrix as being of " relatively tough coarse-grained " hard metal, we mean that the toughness of

and the grain size in the matrix is greater than the toughness of and the grain size in the granules.

With hard metals having the same composition by analysis, a finer-grained hard metal is harder and more wear resistant than a coarser-grained hard metal which is, however tougher. If grain size is decreased the resistance to wear is increased, and if the grain size is increased the toughness is increased. A finer-grained hard metal with a high content of cobalt or other bonding metal is generally more wear resistant than a coarser-grained hard metal with a lower content of cobalt or other bonding metal.

The invention will now be described by way of example with reference to the accompanying drawings, wherein:—

Fig. 1 is a perspective view of a rock drill bit, provided with a cutting insert in accordance with the invention;

Fig. 2 is a magnified section of a part of an insert such as that shown in Fig. 1;

Figs. 3—7 are sections along the line A—A in Fig. 1 of different embodiments of cutting inserts in accordance with the invention;

Figs. 8—10 are sections along the line B—B in Fig. 1 of different embodiments of cutting inserts in accordance with the invention; and

Figs. 11—13 are sections along the line C—C in Fig. 1 of different embodiments of cutting inserts in accordance with the invention.

In Fig. 1 a drill bit 10 has a cutting insert 11 of hard metal forming a chisel edge. The cutting insert 11 is fastened into a groove in the bit 10 by means of brazing, or in any other suitable way. It is, of course, possible to have more than one cutting insert in a drill bit, for instance four cutting inserts may be arranged in cross form, and every cutting insert may be separated into two or more separate parts. The invention is not limited to the plate-like shape of cutting insert shown in the drawings; cutting inserts in accordance with the invention may have other forms. One such form is a cutting insert the sides of which, instead of being substantially parallel as in the inserts shown, are convergent towards the drilling edge, i.e. the base portion is broader than the rest of the insert.

A cutting insert in accordance with the invention may be manufactured as follows:— A fine-grained hard metal powder, having carbide particles of a mean grain size of between 1μ and 2.5μ, is formed into granules of a mean diameter of between 0.05 mm and 6 mm by balling. These fine-grained granules are then mixed in the desired proportions with a coarser-grained hard metal, having carbide particles of a mean grain size of between 3μ and 6μ, the coarser-grained hard metal being either a powder or also in the form of granules formed from the powder by balling. The hard metal is then formed into the shape of an insert prior to sintering by a pressing operation. The hard metal is arranged in the press either as a homogeneous mixture of fine-grained granules with coarse-grained powder or granules, or the concentration of the fine-grained granules may be increased at various places (e.g. towards the top of the insert) as will hereinafter appear. Alternatively the insert may comprise a number of parts each pressed separately, these parts being fitted together for a final pressing before sintering, some parts having fine-grained granules mixed with the coarser-grained hard metal whilst others may consist entirely of coarser-grained hard metal. The powder mixture is then sintered in the usual manner. In this way a satisfactory sintering together of the fine-grained granules and the coarse-grained powder is obtained, and this may be assisted by cobalt migration. Thus, if, for example, the cobalt content is the same for the fine-grained and the coarse-grained material before sintering, there will be a transfer of cobalt from the more coarse-grained to the more fine-grained material during sintering, the fine-grained granules being enriched by transfer of cobalt

Thus, owing to this enrichment, if both the fine-grained granules and the more coarse-grained matrix have, before sintering for instance 8% cobalt, then after sintering, due to cobalt migration, a higher content of bonding metal is obtained in the fine-grained granules of the finished sintered cutting insert than in the more coarse-grained matrix. Depending on the difference in grain size between the fine-grained granules and the more coarse-grained matrix and on the proportions in which they are mixed, significant differences in cobalt content can be obtained. However, there is no difficulty in steering the different factors in such a way that the resistance to wear becomes substantially greater for the fine-grained portions. These points are true, of course, only when the cutting insert is sintered as a whole in one operation.

When parts previously sintered are brazed or forge welded together to form a cutting insert, little or no cobalt migration takes place. Naturally, if there is no cobalt migration or the cobalt migration is insufficient to give a desired higher content of cobalt in the fine-grained granules, the cobalt content of the fine-grained granules must start at a higher value than that of the coarse-grained matrix.

Fig. 2, which is a magnified section of a part of a cutting insert, shows how the fine-grained, more wear resistant, granules 12 are embedded in the more coarse-grained hard metal matrix 13. The fine-grained granules may be uniformly distributed throughout the more coarse-grained hard metal matrix and the fine-grained granule content of the cutting insert may be between 5% and 75% by weight, depending on the characteristics of the stone

that the cutting insert is intended for, and is preferably between 15% and 60%.

It is an advantage, in certain cases, for the concentration and/or size of the fine-grained granules to vary throughout an insert, the variations taking place in any desired direction through the cutting insert. Examples of such inserts are shown in Figs. 6 and 12, where the fine-grained granules 12 are more numerous and more concentrated near the cutting edge of the insert and decrease in number per unit of space in the direction towards the bottom of the cutting insert. The bottom part of a cutting insert may thus become more tough, and the cutting edge more resistant to wear than conventional cutting inserts.

The fine-grained, more wear resistant, granules are usually relatively small, and have a mean maximum dimension (length, breadth or depth) of between 0.05 mm and 6 mm, and may be more or less round, angular or elongated. There may be two or more kinds of fine-grained granules in any one insert the granules having different mean granule sizes, and/or with different mean grain sizes. The different kinds of granule may be uniformly distributed throughout the more coarse-grained matrix, or the distribution of the different granules may be varied in any suitable way. An example of a cutting insert is shown in Fig. 4 which has two kinds of fine-grained granules 14, 15 with a carbide of different mean grain size in each kind; consequently the two kinds of granules have different hardness and wear-resistance.

It is desirable that the carbide grains in the fine-grained granules or in each kind of granule should have a mean grain size below 3.0μ (1μ 10^{-3} mm), preferably between 0.5μ and 3.0μ and that the more coarse-grained matrix should have a mean grain size of more than 2.0μ preferably between 2μ and 6μ. In any case, of course, the grain size in the matrix is always greater than the grain size in the granules.

The fine-grained, more wear resistant granules and the matrix may have substantially the same content of bonding metal. The bonding metal content, for instance, may be 5—12% cobalt and/or other metals in the iron group.

An example of a hard metal is one within the analysis limits 91—94% WC and 6—9% Co., with the fine-grained more wear-resistant granules of a size (mean maximum dimension) between 0.1 and 3 mm and with tungsten carbide particles having a mean grain size between 1μ and 2.5μ, and the more coarse-grained, tougher, matrix with carbide particles having a grain size between 3μ and 6μ. Another example of hard metal, contains 93% WC and 7% Co, with the fine-grained, more wear resistant granules having a slightly higher and the tougher matrix a slightly lower cobalt content, with carbide particles in the fine-grained granules of a mean grain size of 2μ and in the more coarse-grained matrix of a mean grain size of 4—5μ. The fine-grained granules have a mean maximum dimension between 0.1 mm and 1 mm. In a further example the fine-grained, more wear resistant granules are of two different kinds, distinguished by the size of the carbide particles. One kind has a mean carbide grain size of 1.5μ and the other has a mean carbide grain size of 2μ, while the carbide particles of the tougher matrix have a mean grain size of 3.0μ.

It may be preferable to form the cutting insert with one or more separate zones, each consisting of the coarse-grained matrix with embedded fine-grained granules. Where there is more than one such zone, different zones may have fine-grained granules of different grain sizes, and there may be parts of the cutting insert which consist wholly of the coarse-grained material. Cutting inserts of this type are shown in Figures 5—7, 9, 10, 12 and 13. The zone or zones may extend to the opposite ends of the insert at the cutting edge thereof, and have parts consisting wholly of matrix on both sides thereof at the cutting edge. The zone or zones of coarse-grained matrix with embedded fine-grained granules can form a centrally disposed, substantially plate- or wedge-shaped layer which extends in the longitudinal direction of the cutting insert (see Fig. 5 in particular).

The distribution of fine-grained granules throughout may be such that the bottom or sides of the insert consist substantially or completely of the more coarse-grained hard metal such as is shown by the reference numeral 16 in Figs. 9, 10, 12 and 13.

Where the cutting insert is made by sintering as a unit the boundaries between the zones containing the fine-grained granules in the coarse-grained matrix and/or between such zones and parts consisting solely of matrix may be sharp or may show a more or less continuous mergence. It may be found suitable, by means of brazing or forge welding, to fasten zones consisting of more coarse-grained matrix with embedded fine-grained granules to, for instance, one or more coarse-grained hard metal parts.

Figs. 3, 8 and 11 show a cutting insert, in which the fine-grained granules are uniformly distributed throughout the matrix.

WHAT WE CLAIM IS:—

1. A rock drill cutting insert comprising a zone consisting of discrete granules of relatively hard fine-grained hard metal embedded at random in a matrix of relatively tough coarse-grained hard metal.

2. A cutting insert as claimed in claim 1 wherein the fine-grained and coarse-grained hard metals have the same chemical composition by analysis.

3. A cutting insert as claimed in claim 1 wherein the fine-grained hard metal has a higher content of bonding metal than the coarse-grained hard metal.

4. A cutting insert as claimed in any one of the preceding claims, wherein the fine-grained hard metal is in granules of at least two different sizes.

5. A cutting insert as claimed in any one of the preceding claims, wherein the fine-grained hard metal is in two kinds of granules each containing hard material of a different grain size.

6. A cutting insert as claimed in any one of claims 1 to 5, wherein the concentration of the fine-grained granules decreases in the direction away from the cutting edge towards the bottom of the insert.

7. A cutting insert as claimed in any one of claims 1—3 wherein the fine-grained granules are uniformly distributed throughout the matrix.

8. A cutting insert as claimed in any one of claims 1 to 6, wherein the bottom of the insert is free of fine-grained granules.

9. A cutting insert as claimed in any one of claims 1 to 6, or in claim 8, wherein the fine-grained hard metal granules are more concentrated in one zone of the matrix than in an adjacent zone of the matrix.

10. A cutting insert as claimed in any one of claims 1—6 comprising at least one zone consisting of discrete granules of relatively fine-grained hard metal embedded at random in a matrix of relatively coarse-grained hard metal and a part consisting entirely of matrix.

11. A cutting insert as claimed in claim 10, wherein the said zone extends to the opposite ends of the insert at the cutting edge thereof and has parts of matrix on both sides thereof at the cutting edge.

12. A cutting insert as claimed in any one of the preceding claims, wherein the fine-grained granule content of the insert is between 15% and 60% by weight.

13. A cutting insert as claimed in any one of the preceding claims, wherein the fine-grained granules have a mean maximum dimension of between 0.05 mm and 6 mm.

14. A cutting insert as claimed in any one of the preceding claims, wherein hard material particles in the fine-grained granules have a mean size being below 3μ.

15. A cutting insert as claimed in claim 14 wherein the mean grain size of the hard material particles in the fine-grained granules is between 1μ and .5μ.

16. A cutting insert as claimed in any one of the preceding claims wherein the grain size of the hard material particles in the matrix is between 3μ and 6μ.

17. A cutting insert as claimed in any one of the preceding claims, wherein the cutting insert is a sintered unit.

18. A cutting insert substantially as described herein with reference to Figs. 1 and 2 and any one of Figs. 3—13.

19. A cutting insert as claimed in any one of the preceding claims made from material described in any of the examples given herein.

20. A rock drill bit provided with a cutting insert as claimed in any one of the preceding claims.

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806,406 COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

Fig 1

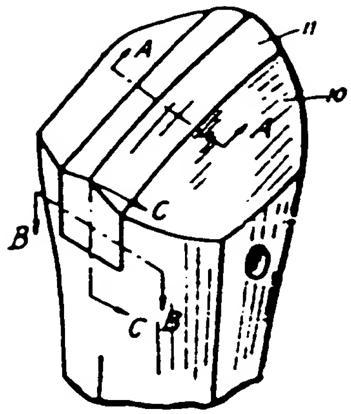

Fig 2

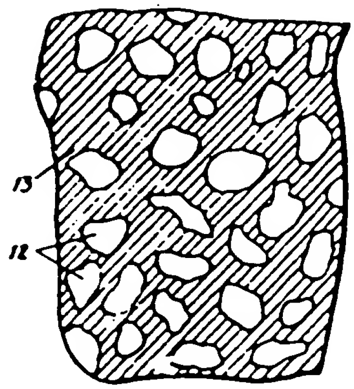

Fig. 3

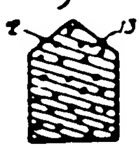

Fig. 4

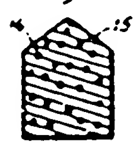

Fig. 5

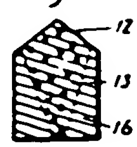

Fig. 6

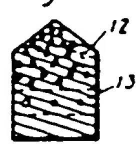

Fig. 7

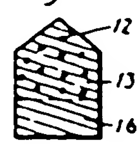

Fig. 8

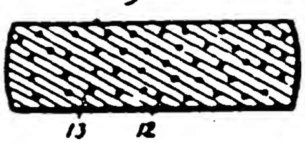

Fig. 9

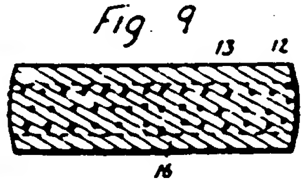

Fig. 10

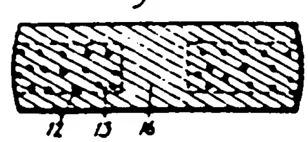

Fig. 11

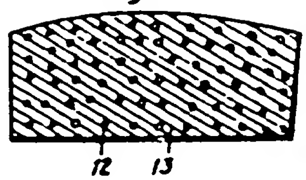

Fig. 12

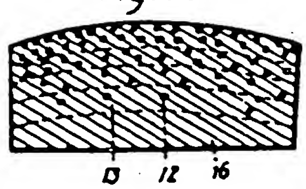

Fig. 13